Space Weather Technical Forecast

Issued on Saturday, 10 December 2022 at 12:34 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Increasing Chance of M-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with an erratic X-ray trace at GOES16 showing occasional bouts of middling C-class flares. The largest of these flares was a C6.0 observed at 09/1413UTC from newly-numbered AR3163 near the southeastern limb. This group appears to be largely responsible for the uptick seen in X-ray activity over the last 30 hours, and although it currently presents as a Dhi/Beta, further rotation may yet reveal more detail.

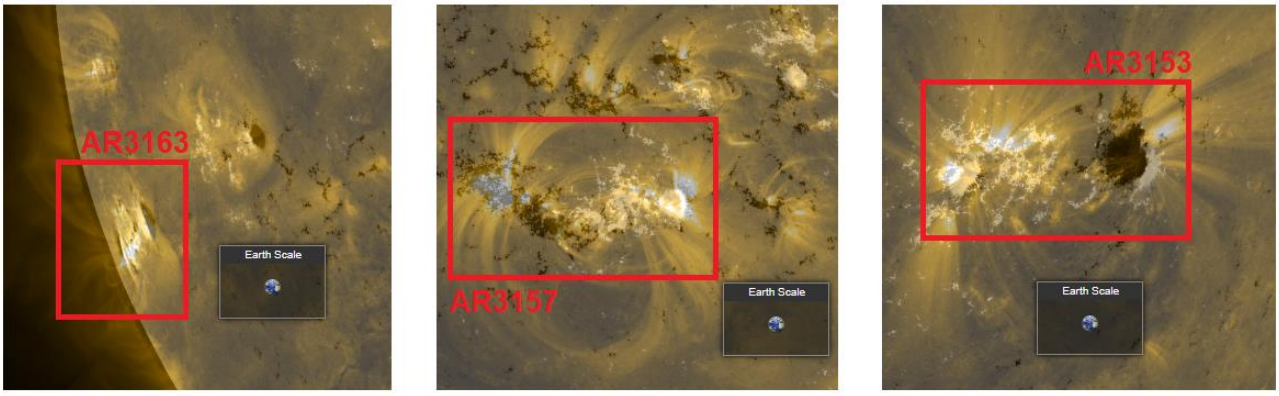

Figure 0: Helioviewer.org derived overlaid HMIBC and AIA171 imagery, showing the three main active regions on the current disc.

The above was one of up to eight sunspot regions on the disc. This roster continued to include the very large AR3153, although this showed a tendency towards becoming more symmetric and with fewer intermediate spots visible. Also of note was AR3157, which showed a Mt Wilson delta spot for a time, although this diverged into the current UTC day. The intermediate spots remained dynamic but ceased to be generated. All the other sunspot regions on the disc were either magnetically 'unipolar' or else simple dipoles with small changes evident.

There were no obvious movements in front-sided filaments in the period, and while AR3163 appears to have produced some small CMEs, these do not carry an Earth-directed component. A halo signature on Lasco imagery visible through the early hours UTC of 10 December did not correlate with any front side event. No Earth-bound CMEs were observed in the period.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by DSCOVR, were indicative of an ongoing, slightly weakening connection to the fast wind emanating from CH53/-, and the phi angle was accordingly negative (towards the Sun) throughout.

The solar wind speed was Elevated at first, but gradually fell to Slightly Elevated levels near 450

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with time. The solar wind density showed a slight drop over the same interval: from near 10ppcc into single figures as Saturday arrived. The IMF was steady at a peak of 8nT, with a north-south range of +/-7nT.

The net result of the above solar wind measures was for mostly Quiet geomagnetic activity, provisionally peaking at an Unsettled '3-' in the 00-03UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 has remained at Background levels.

High energy electron flux (greater than 2 MeV), as observed by GOES16, has been at Background to occasionally Moderate levels, peaking at 139pfu at 09/1915UTC. The associated 24-hour fluence remained below Active (1e8 integrated pfu), with a very gradually rising trend. Observed fluence at 10/0001UTC was 1.58e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a chance of isolated M-class flares each day, currently most likely from newly-designated AR3163, but AR3153 or AR3157 remain nominally complex. Further arriving regions into the coming UTC working week should see the risk of significant flares increase slightly further still, although M-class should remain within 'Chance'.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs currently feature in the forecast.

The coming four days are potentially bookended by coronal hole fast winds, firstly the current CH53, which carries a vestigial Chance of delivering further Unsettled intervals over the current UTC weekend. A new, unnumbered negative polarity coronal hole may then arrive later on 13 December, with low confidence in the potential for further Unsettled intervals at this time, else the intervening days should largely revert to Quiet.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is expected to remain at Background levels throughout, with a daily Slight Chance of seeing S1+ levels if any significant flares were to occur.

High energy electron flux (greater than 2 MeV) is expected to remain at predominantly Background to Moderate levels, but with an increasing trend, which brings a chance of occasional High levels (1000 pfu) being reached at times later in the period. The corresponding high energy electron fluence is expected to remain below the Active (1e8 integrated flux) threshold, despite the suggested eventual upward trend.

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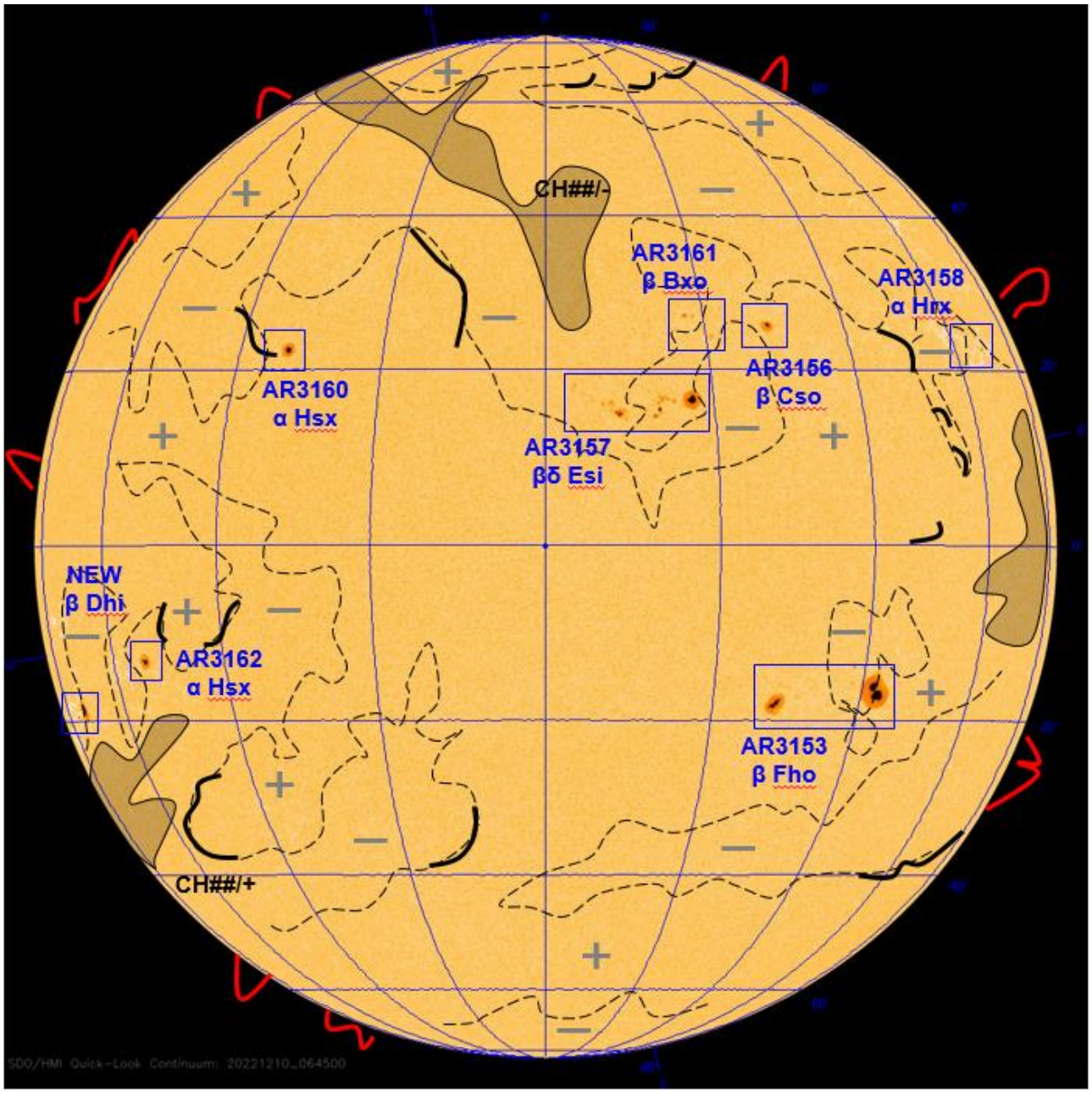
Figure 1. Solar Analysis Valid 10/0645UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

No Earth-directed CMEs feature in the current forecast.

The solar wind is currently under the residual influence of CH53. Looking upwind to STEREO A, the satellite suggests the solar wind should remain near Elevated levels for at least the coming 24 hours (i.e. around 500km/s), but thereafter a declining trend in the solar wind speed is expected.

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MOSWOC Enlil then suggests that a negative polarity unnumbered coronal hole should become geoeffective through the course of the UTC day of 13 December, day four. There was a similarly-located coronal hole present here on last rotation (13 November), however this did not produce noteworthy geomagnetic activity. This fact, coupled with our proximity to the solstice should limit any resulting effects from this feature.

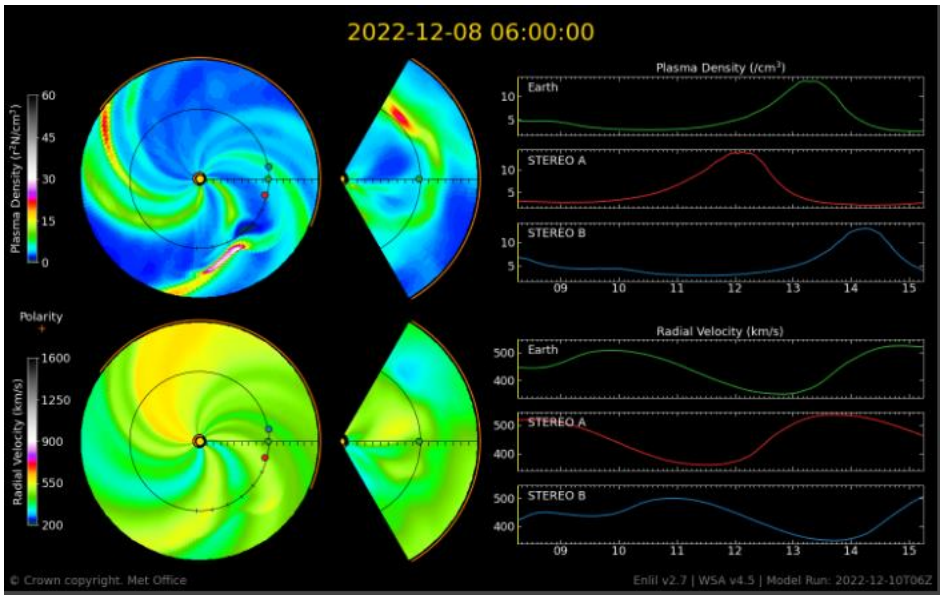
The geomagnetic forecast is therefore bookended by coronal holes, giving perhaps a Chance of Unsettled intervals to start and end the four days, else becoming Quiet in the intervening period.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: MOSWOC Enlil run showing similar magnitude fast wind streams from current CH53/-, and a possible forthcoming unnumbered coronal hole on 13 December. The latter is low confidence and is being treated in a volatile manner by successive Enlil runs. Significant geomagnetic activity is not expected.



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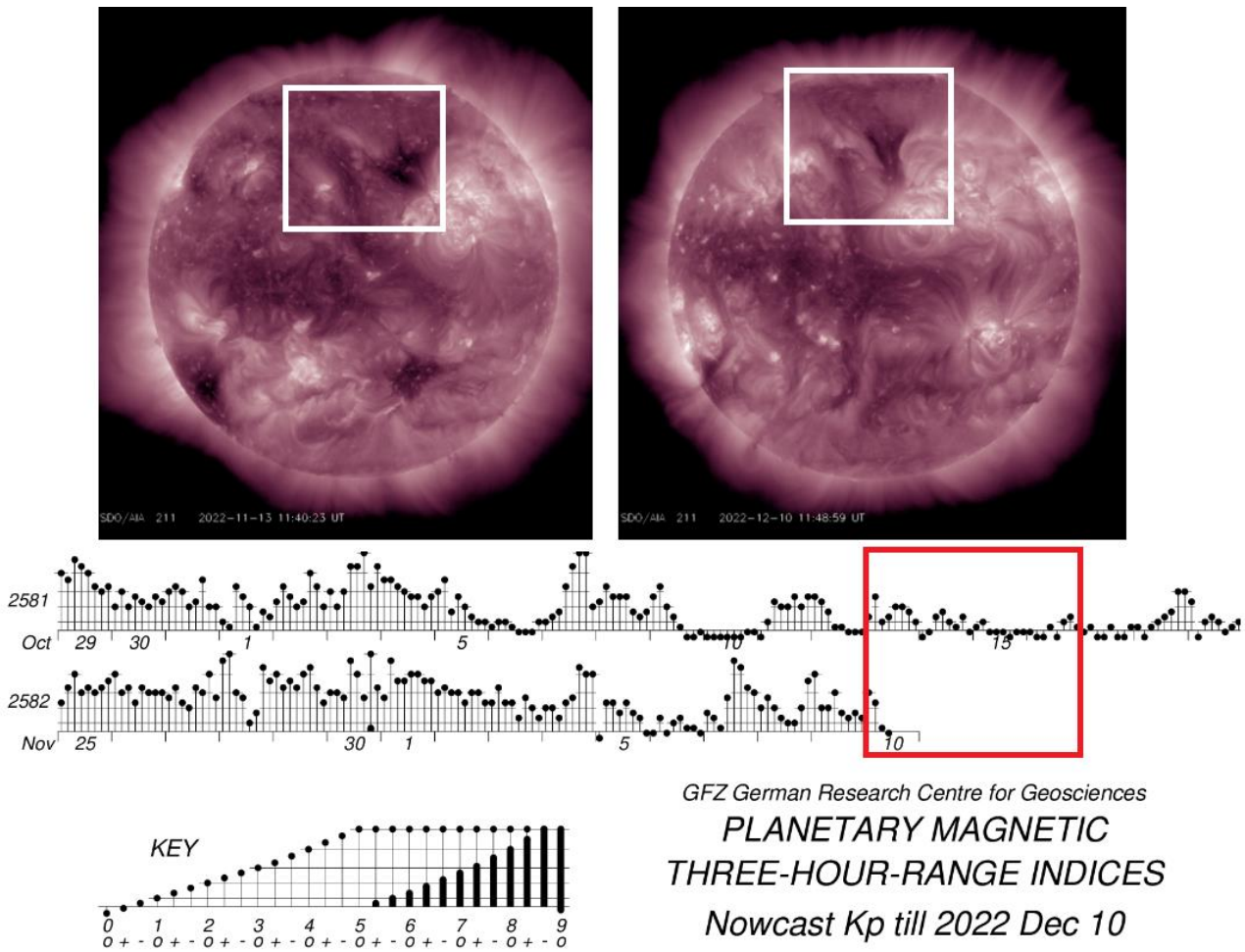
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2581
Oct 29 30 1 5 10 15
2582
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GFZ German Research Centre for Geosciences
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Nowcast Kp till 2022 Dec 10
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0 1 2 3 4 5 6 7 8 9
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Figure 3: AIA211 imagery from previous (top left) and current (top right) rotations. Note that although there was a precedent, it is tenuous then and now. Resultant geomagnetic activity was negligible as a result - the fast wind largely (entuirely?) passing above the eclliptic plane.

Radio Blackouts - X-Ray Flares:

There are currently eight numbered sunspot regions on the visible disc, including the newly-designated AR3163 in the southeast, which appears as a Dhi/Beta in the latest imagery. This sunspot region has been the main cause of the significant observed uptick in solar activity in the past 24 hours, with a flat trace near the boundary of B and C-class flux at GOES16 giving way to occasional md-ranking common class flares and eastward-directed CMEs. It remains possible that further rotation may reveal extra detail in this group, with the Dhi/Beta designation considered conservative for now.

The Carrington locations for Ex-3147, 48 and 49 are all due over the eastern solar horizon into the start of the forthcoming UTC working week, and as such the probabilities of X-ray flares should increase. This has been suggested at in recent east limb activity, although this does appear to largely be tied to the now-observable AR3163.

No significant regions leave the Earth-facing side in the four days, and as such the chances of significant flares increase slightly as the front side is populated by the (possible) new arrivals.

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X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	35	40	40
Very Active	R3 to R5 X Class	No	1	2	5	5

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is most likely to remain at Background levels throughout.

There remains a daily Slight Chance of seeing S1 or greater levels at GEO if any significant flares were to occur. The stated flat 5% risk is mainly due to the nominal presence of complex AR3153 and AR3157, although neither has lived up to its billing thus far, and neither has a history of producing any proton enhancements. The arrival of possible significant eastern horizon sunspot groups will take some time yet to manifest on proton risks.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV) is likely to react upwards to the previous Elevated solar wind speeds and ongoing HSS influence, now that the peak threat of associated geomagnetic activity has passed.

The onset of this suggested rise is now later than expected, and may also be more muted than anticipated as a result. Electrons should rise to find their level by the end of the current UTC weekend, however this now looks more likely to result in sub-Active 24-hour integrated electron fluence.

MOSWOC Enlil remains steadfast in suggesting that a new high speed stream ought to round out the four-day forecast period. This hole is a negative polarity feature that extends down from the northern hemisphere towards the solar equator. This may serve to dent electron counts at the very end of the period.

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GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^{8}$**	No	1	30	30	20
Very Active	**≥ 2 MeV ≥ $1x10^{9}$**	No	1	1	1	1

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